

28. The fuel additive composition of claim 27 wherein the commercially available liquid hydrocarbon fuel comprises from about 999,750 to about 999,980ppm by weight of said composition.

29. The fuel additive composition of claim 27 wherein the commercially available liquid hydrocarbon fuel is selected from the group consisting of gasoline, jet fuel, kerosene and diesel fuel.

30. The fuel additive composition of claim 27 wherein the surfactant comprises from about 50 to about 150ppm by weight of said composition.

31. The fuel additive composition of claim 27 wherein the co-surfactant comprises from about 20 to about 40ppm by weight of said composition.

32. The fuel additive composition of claim 27 wherein the hydrocarbon solvent is kerosene.

33. The fuel additive composition of claim 27 wherein the micro-emulsified water comprises from about 20 to about 85ppm by weight of said composition, such that the weight ratio of said surfactant to said micro-emulsified water falls within the range of from about 3:1 to about 1:1.

34. The fuel additive composition of claim 27 wherein the surfactant is a combination of amine alkylbenzene sulphonate, POE (20) sorbitan monooleate, tall oil fatty acids, oleyl imidazoline hydrochloride and oleamide diethanolamine.

35. The fuel additive composition of claim 27 wherein the co-surfactant is a combination of methanol, ethylene glycol n-butyl ether and dipropylene glycol methyl ether.

REMARKS/ARGUMENTS

1. The Examiner's comments have been well noted and in order to more clearly define the exact nature of our invention it has been necessary to rewrite some of the application; including all the Claims, the Abstract, one paragraph from the Background of the Invention, one paragraph from the Objects of the Invention, and twelve paragraphs from the Description of Preferred Embodiment. All minor amendments found to be in non-compliance (37 CFR 1.121) from previous papers #5, #7 and #8 have also been incorporated. No new matter has been added, however, some rewriting was necessary to correct imprecise and unclear wording.

Re: Section 112 Objections:

1. *"Claims 9 and 14 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. Claims 9 and 14 remain rejected under 35*

U.S.C. 112, second paragraph, because it is confusing that the micro-emulsion forming additive comprising a surfactant, co-surfactant, water and balance being hydrocarbon that appear to be in conflict with claim 5 that does not include hydrocarbon in the said additive. Also, "Claims 9 -18 will not be treated on the merits because the scope of the claims cannot be determined."

Accordingly, the Claims of record (1 to 19) have all been rewritten and replaced with new Claims (20 to 35) in order to address Section 112 objections as well as define the invention more particularly over the cited references.

2. *The phrase "the remaining portion is liquid hydrocarbon fuel" is broader than and is in conflict with page 9, lines 17-20 that the concentrated additive is pre-diluted with kerosene (or some other solvent/distillate)."*

When the kerosene is mentioned on page 9, lines 17-20 of the instant application it is simply being employed as an inactive dilutant. When being used for this purpose, the kerosene was never intended to be considered an active functional component of the fuel additive concentrate. However, since applicant's examples 7, 8, 10, 11 and 16 have always employed kerosene as a functional component, and to avoid further confusion, all the rewritten claims now include the use of an extra ingredient called a "hydrocarbon solvent" to represent the kerosene when it is being used this way.

Re: Section 103 Objections:

1. *"Claims 1-8 and 19 for reasons made of record in paper No. 2 dated September 5, 2002 remain rejected under 35 U.S.C. 103(a) as being unpatentable over patents of Grangette, McCoy and Wenzel. The Admitted prior art Grangette renders the instant claim additives obvious because of the lower range of 100ppm water of Grangette suggests the upper range of 95ppm water of the instant claims, in the absence of evidence of record to the contrary".*

The Grangette patent (US #4,396,400) is admitted prior art and is clearly distinguishable over the instant application. Grangette discloses 100 to 5,000ppm water in the fuel (column 4, line 5 to 6). The instant application deals only with those fuels dosed with an extra 5 to 95ppm water (page 10, line 5). Although the water content ranges approach each other, they actually teach moving in opposite directions. Grangette discloses that 1,000ppm water content gives optimum overall improvement (column 6, lines 10 to 12). Applicants teach that 20 to 80ppm water is preferred (page 10, line 5).

Further consideration of the instant application test data examples #13 to #20 are submitted as the requested "*evidence of record to the contrary.*" In these eight examples, vehicles treated with additional water (significantly less than 100ppm) all achieved remarkable emissions reductions as well as fuel economy improvements (page 31, table 6). This clearly demonstrate that below 100ppm additional water, emissions reductions and fuel economy benefits can improve as the water content reduces further. More significantly, not only do the benefits increase, but the treatment costs reduce proportionally. There is therefore a threshold in the cost/benefit ratio which cannot be crossed except in fuels treated with less than 100ppm water. No prior art demonstrates this new and unexpected result.

"It is the Examiner's position that from 0% to 25% by weight co-surfactant read on the component not being present. When the co-surfactant is absent from the said composition, the instant claims comprises 10 to 65% by weight water and 90 to 35% surfactants and the instant ranges are rendered obvious by the range of surfactants to water of Grangette."

Applicants have therefore narrowed the percentage ranges of water and surfactant (refer to instant application new claim #20). Surfactants are now 80 to 30%; water is 10 to 60%.

Grangette does not actually state a ratio range of surfactant to water; this ratio can only be calculated from examination of the various examples. This calculation reveals a ratio range of surfactant to water of from 0.6:1 to 0.25:1.

Applicants, however, do state a ratio range for the surfactant to water. This range is 8:1 to 0.5:1 (page 9, line 7). This difference in surfactant to water ratio (8:1 to 0.5:1 vs. 0.6:1 to 0.25:1) now clearly demonstrates a major significant difference between the instant application and Grangette.

Applicants also couple this unusual surfactant to water ratio together with the low water content as the essence of the present invention (page 11, lines 14 to 16)

Grangette teaches the quantity of surfactant utilized is proportional to the quantity of water to be solubilized (column 3, lines 53 to 54). However, Grangette clearly does not follow this teaching. This is particularly true in the only two Grangette examples using less than 1,000ppm water. Examples #2 (column 5) and #17 (column 8) each use only 100ppm water but have a surfactant to water ratio of only 0.25:1. Fuel emulsions containing water near the critical 100ppm level need more surfactant (to compensate for the 75ppm water dissolved in the fuel). However, Grangette actually uses less surfactant.

Stated in a more general way, Grangette fuels always use more water than surfactant, whereas applicant's fuels always use less water than surfactant (except only in the present invention example #20). Therefore, applicants resubmit that Grangette does not render obvious the surfactant to water ratios of the instant application.

"The teachings of McCoy and Wenzel are incorporated into Grangette." Also, "McCoy teaches non-ionic surfactants and Wenzel teaches cationic surfactants." Also, "McCoy and Wenzel provide the motivation that the same additives used in diesel fuel emulsions e.g. gas oil, have the same functional properties in gasoline fuel emulsion providing the motivation that the fuel composition of Grangette can be used in gasoline and diesel fuel."

The Grangette patent employs an amphoteric betain derivative as the emulsifying surfactant. McCoy teaches nonionic surfactants and Wenzel teaches cationic surfactants as the emulsifiers. There is no suggestion in the references themselves that they be combined. Thus, the applicant submits that any combination of Grangette with the other two references is an improper one, absent any showing in the references themselves that they can or should be combined. Even if McCoy and Wenzel could be incorporated into Grangette, and the resulting fuel emulsions used in both gasoline and diesel fuel, this would still not show the instant application or render it obvious because of the other significant differences. Applicants deliberately disclose that various types of surfactants could be used to produce fuel emulsions (page 11, lines 11 to 16).

For clarity, applicants restate the significant differences between the present invention and Grangette: Applicant's fuel emulsions teach less than 100ppm water,

Grangette teaches more than 100ppm. Applicants teach more surfactant than water, Grangette teaches less surfactant than water. Applicant's fuel emulsions are prepared by using a pre-mixed additive, Grangettes fuels are not. Applicant's fuel emulsions recognize and cross the cost/benefit threshold necessary for commercial success, the Grangettes fuels do not.

2. McCoy (3,876,391). Unlike the instant application, the McCoy fuel emulsions were not built by incorporating a pre-mixed additive into a commercially available fuel. Water soluble surfactants and oil soluble surfactants were separately added to the water and the fuel (column 7, lines 44 to 48 and column 8, lines 1 to 12). This would make production complicated, time consuming and expensive for any emulsion fuel producer (since all of the fuel must pass through the production facility).

The McCoy fuel emulsions have typical water contents from about 60,000 to 160,000ppm (column 6, line 35). The instant application uses only about 5 to 95ppm water (page 10, line 5). McCoy emulsion fuels would therefore present a significant danger to engines if the emulsion broke. The instant application would not present such a danger.

McCoy fuel emulsions use a total surfactant content of 60,000 to 160,000ppm (column 6, line 36). Applicants use about 10 to 400ppm surfactant (page 10, line 3). Since the extra cost to produce the emulsion fuel is mostly in the surfactants, this makes the McCoy fuel emulsions about 500 times more expensive than the instant application, just for the major raw ingredient. The McCoy fuels could never be cost effective.

Unlike the instant application, the McCoy fuel emulsions do not claim to improve fuel economy or reduce exhaust emissions, their primary function is to use the emulsified water as a vehicle to carry water soluble octane boosters (column 2, lines 32 to 34).

3. Wenzel (4,083,698). Wenzel seems preoccupied with low temperature stability of fuel/water micro-emulsions. There are 87 tests, of which only one test (example #6) actually uses this fuel in an engine. All the other tests are concerned with low temperature fuel stability.

Unlike the instant application, the Wenzel fuel emulsions were not built by incorporating a pre-mixed additive into a commercially available fuel. All the surfactants were pre-blended (column 9, lines 35 to 50) and then mixed into a gasoline together with co-surfactants and water (column 11, lines 47 to 57). This would make fuel production complicated, time consuming and expensive for any emulsion fuel manufacturer (since all of the fuel must pass through the production facility).

Wenzel claims fuel emulsions having a water content range from about 5,000 to 25,000ppm (column 5, lines 62 to 63). Applicants use only about 5 to 95ppm water (page 10, line 5). Wenzel emulsion fuels would therefore present a significant danger to engines if the emulsion broke. The instant application would not present such a danger.

Wenzel does not actually state a range of surfactant content, so using the only example cited by Wenzel which is actually used in an engine (example #6) gives a surfactant content of 69,000 to 105,000ppm in the fuel. The instant application uses about 10 to 400ppm surfactant (page 10, line 3). Since the extra cost to produce the emulsion fuel is mostly in the surfactants, this makes the Wenzel fuel emulsions about

400 times more expensive than the instant application, just for the major raw ingredient. The Wenzel fuels could never be cost effective.

Unlike the instant application, the Wenzel fuel emulsions do not claim to improve fuel economy, their primary function seems to remain stable as the temperature changes.

Re: Cited But Non-Applied References:

1. Goddard (4,605,422), Hellsten (4,315,755), Wenzel (4,002,435), Friberg (3,902,869) and Kirschbraun (1,701,621). These references have been cited but not applied against any claim. Applicants have reviewed them, but none show the present invention or render it obvious.

Additional Reasons Mitigate in Favor of Unobviousness:

1. The invention can be employed in a cost effective manner not previously realized. This is by using the fuel economy improvements coupled with the low treatment level. Up until now, those skilled in the art have never disclosed a cost effective emulsion fuel additive. Applicant's additives can be sold at a typical retail level treatment cost of only about 4 cents per gallon of fuel treated (copy of assignee's web site price list enclosed). If fuel costs are \$1.50 per gallon, saving 10% (refer to instant application test #14) would mean saving 15.0 cents per gallon. Comparing the cost of treatment (4 cents per gallon) with the fuel savings (15.0 cents per gallon) clearly demonstrates cost effectiveness.

2. The instant application also solves an unrecognized problem associated with low water content fuel emulsions. Without extra surfactants, any low water content fuel emulsion (typically 50ppm added water) would slowly be overwhelmed by the background level of dissolved water always present in all commercially available fuels (typically 50 to 100ppm). By employing unusually high surfactant to water ratios of typically 3:1 to 1:1 (page 10, line 7), applicants achieve the long term emulsion fuel stability essential to commercial success.

3. Applicant's Patent Application (#20020095859) was published July 25, 2002. So far as the applicants are aware, no public challenges have yet been made against this application in the one year that it has been in the public domain. This mitigates in the applicant's favor.

4. Fuel additives in accordance with the instant application are already being sold by the applicant's assignee (H2OIL Corporation) in several countries to individuals with various driving habits for use in both gasoline and diesel fuel. There are few complaints and none indicating that the mixtures become unstable.

5. Applicant's fuel additives have already achieved a significant level of commercial success. Assignee's additives are currently the #1 selling retail fuel additive in Japan (sold by Kure under the trade names "Power Booster" and "Super Power Booster"). Assignee has also achieved substantial sales in China, Thailand, Singapore and Malaysia.

During the last three years, assignee overseas sales for fuel additives have been well over \$3 million (verification available on request).

6. The instant application is in a crowded art (fuel emulsions). It is well recognized that in a crowded art, even a small step forward is worthy of patent protection. While the instant application is submitted to be far more than a small step forward, nevertheless this factor mitigates in the applicant's favor.

7. If the instant application were in fact obvious; because of its advantages, those skilled in the art would surely have implemented it by now. The prior art references cited by the Examiner are all out-of-force patents (the earliest cited patent issued in 1929). The fact that those skilled in the art have still not implemented the instant application by now, despite its great advantages, indicates that it is clearly not obvious.

8. The instant application solves a long-felt, long-existing, but unsolved need. This would be a simple and cost effective means to quickly and easily reduce urban air pollution from vehicle exhausts (fuels using applicant's fuel additive have significantly reduced exhaust emissions). It is easily mixed with the fuel. No fuel distribution infrastructure changes are required. Once in the fuel supply, applicant's fuel additive would quickly reach all of the vehicle population. No vehicle modifications are required. The low water content makes it safe to use. Fuel savings more than compensate for additive costs (most users actually make a profit, see paragraph 1. above).

9. Applicant's fuel additives have received professional recognition. In 1994, applicants were invited by the United Nations to attend a Hong Kong conference on transport related urban air pollution problems (copy of official U.N. invitation is attached). Also in 1994, a Forbes Magazine article describes the applicant's fuel additive technology as "one of the best 25 emerging environmental technologies in the world" (copy of magazine article enclosed).

10. Attempts have already been made to copy the applicant's fuel additive technology by an infringer (Peking University, China). Moreover, this infringer has made laudatory statements about the additive. Copy of assignee's web site (H2OIL) and infringer's web site (PKU) are attached for comparison (also note that PKU even copies the assignee's literature word for word). This infringer was apparently unable to copy the present invention until a sample of the assignee's fuel additive was obtained from a local Chinese distributor. Infringer was then able to try reverse engineering, but only managed to produce an inferior product (now temporarily withdrawn from the market, due to technical problems).

Marked-up Version:


Attached hereto is a marked-up version of the changes made to the Abstract, Background of the Invention, Description of the Preferred Embodiment and Claims. The attached pages are captioned "**Version with markings to show changes made.**"

Reconsideration Request:

Further to the above additional reasons, and since the novel features of the instant application provide new and unexpected results over any reference, applicant submits that these new results indicate unobviousness and hence patentability. Accordingly, applicants respectfully request reconsideration and allowance of the instant application with the above new claims.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE**In the ABSTRACT:**

1. The abstract of record has been completely rewritten as follows:

-- A liquid nanotechnology (micro-emulsion forming) fuel additive composition which reduces the exhaust emissions and improves the fuel economy of internal combustion machines when used at a dose level of 20 to 500ppm in the fuel. --

-- ~~High surfactant to water ratios on the order of 2.5:1 in a concentrated a micro-emulsion forming fuel additive produces improved hydrocarbon fuel combustion at only 5 to 95 parts per million of additional water.~~ --

In the BACKGROUND OF THE INVENTION:

1. The paragraph beginning at page 2, line 3, has been completely rewritten as follows:

-- This invention relates to a liquid nanotechnology (micro-emulsion forming) fuel additive composition which reduces the exhaust emissions and improves the fuel economy of internal combustion machines when used at a dose level of 20 to 500ppm in the fuel. --

-- ~~This invention relates to a micro-emulsion fuel additive containing water which improves combustion of hydrocarbon fuels in internal combustion machines.~~ --

2. Paragraph beginning at page 3, line 1, has been amended as follows:

-- Grangette et al U.S.Patent 4,396,400 discloses that it is possible to produce a low water content fuel emulsion by adding at least 100 ppm of additional water in forming a micro-emulsion fuel with low surfactant content 25 ppm, which gives reasonable emissions reductions when tested in a vehicle on a chassis dynamometer. However, such a mixture is not stable at a surfactant to water ratio of only 0.25:1 and has not been adopted in the real world. --

In the OBJECTS OF THE INVENTION:

1. Paragraph beginning at page 3, line 8, has been amended as follows:

-- It is an object of this invention to provide additional water to liquid hydrocarbon fuels in the form of a micro-emulsion to enhance fuel efficiency. --

In the DESCRIPTION OF PREFERRED EMBODIMENT:

1. Paragraph beginning at page 3, line 13, has been completely rewritten as follows:

-- Fuel additive compositions are formulated which can be mixed with commercially available liquid hydrocarbon fuels (such as gasoline, diesel fuel, kerosene or jet fuel) to form stable "water-in-oil" type micro-emulsions. Improved combustion and fuel efficiency can be achieved by adding 20 to 500ppm of the additive into the hydrocarbon fuels. Long term stability of this low dose level micro-emulsion fuel is achieved by using high surfactant to water ratios in the additive from about 8:1 to 0.5:1 and more preferably from about 3:1 to 1:1. --

~~-- Fuel additive compositions are formulated which can be mixed with commercially available liquid hydrocarbon fuels (such as gasoline, diesel fuel or jet fuel) to form stable "water-in-oil" type micro-emulsions. Improved combustion and efficiency can be achieve by adding as little of the composition as needed as to result in 5 to 95 ppm (parts per million) of water in the hydrocarbon fuel. Stability of this low water content micro-emulsion fuel is achieved with use of high surfactant to water ratios in the additive between 8.0:1 and 0.5:1, preferably between 3.0:1 and 1.0:1 and most preferably 2.5:1. The resulting micro-emulsion fuel exhibits improved fuel economy and reduced exhaust emissions.~~ --

2. Paragraph beginning at page 3, line 21, has been completely rewritten follows:

-- The fuel additive composition should comprise in admixture form, from about 10% to 60% (preferably 20% to 50%) by weight of water; from about 30% up to 80% (preferably 40% to 70%) by weight of a surfactant selected from the group consisting of amphoteric, anionic, cationic and non-ionic surfactants (preferably selected from the group consisting of amine alkylbenzene sulphonate, POE [20] sorbitan monooleate, tall oil fatty acids, oleyl imidazoline hydrochloride and oleamide diethanolamine); from 0% to 30% (preferably 10% to 20%) by weight of a co-surfactant selected from the group consisting of alcohols, glycols, and ethers (preferably selected from the group consisting of C1 to C4 alcohols, C2 to C3 glycols and glycol ethers); and from about 0 to about 30% (preferably 0%) by weight of a hydrocarbon solvent (preferably kerosene). --

~~-- The fuel additive composition should be added to commercially available liquid hydrocarbon fuels at a dose ratio such that all water in such fuel after incorporation comprises from 5 to 95 ppm by weight of the combined hydrocarbon fuel. The additive before adding should comprise from 10% to 60% by weight of water, preferably 20% to 80% by weight; from 0% to 25% by weight of one or more co-surfactants selected from the group consisting of alcohols, glycols, and ethers preferably selected from the group consisting of C₁ to C₄ alcohols, ethylene glycol and glycol ethers; and the balance up to 100% by weight of one or more surfactants selected from the group consisting of amphoteric, anionic, cationic and non-ionic surfactants, preferably selected from the~~

group consisting of amine alkylbenzene sulphonate, POE (20) sorbitan monooleate, tall oil fatty acids, oleyl imidazoline hydrochloride and oleamide diethanolamine; and such that the ratio of the surfactant to the water falls within the range from 0.5:1 up to 8.0:1, preferably within the range 1.0:1 to 3.0:1 and most preferably 2.5:1. --

3. Paragraph beginning at page 4, line 7, has been replaced with the following paragraph:

-- When the fuel additive dose level becomes so low that the background quantity of dissolved water in the fuel starts to become significant, then it is critical to increase the surfactant to water ratio in the additive to compensate for the extra water in the fuel. --

-- The fuel additive compositions including the preferred ones are prepared by mixing the above components sufficiently to form a micro-emulsion additive. --

4. Paragraph beginning at page 4, line 9, has been rewritten as follows:

-- A fuel composition, intended to be combusted in internal combustion machines, is prepared by mixing the above described fuel additive composition at a dose level from about 20 to 500ppm (preferably 20 to 250ppm) in a liquid hydrocarbon fuel (preferably from the group comprising gasoline, jet fuel, kerosene and diesel fuel). --

-- A suitable liquid fuel composition is prepared by mixing a liquid hydrocarbon fuel mixed with the above described micro-emulsion forming additive so that the composition comprises: from 10 to 400 ppm of one or more surfactants selected from the group consisting of amphoteric, anionic, cationic and non-ionic types; from 0 to 100 ppm of one or more co-surfactants selected from the group consisting of alcohols, glycols, and ethers; and from 5 to 95 ppm of added water with the ratio of surfactant to added water being in the range from 0.5:1 to 8.0:1; and the remaining portion is liquid hydrocarbon fuel. A preferred range for the added water is in the range of 20 to 80 ppm. A preferred ratio of surfactant to added water being in the range of 1.0:1 to 3.0:1. A preference in surfactants is a selection from the group consisting of amine alkylbenzene sulphonate, POE (20) sorbitan monooleate, tall oil fatty acids, oleyl imidazoline hydrochloride and oleamide diethanolamines. A preference in the selection of the co-surfactants is selected from the group consisting of C₁ to C₄ alcohols, ethylene glycol and glycol ethers. A preference in the liquid hydrocarbon fuel is from the group boiling in the gasoline to diesel fuel range; --

5. Paragraph beginning at page 4, line 22, has been amended as follows:

-- Internal combustion engines normally show variations in the maximum cylinder pressure and rate of pressure rise from cycle to cycle which is known as cyclic dispersion. This is due to variations in turbulence between cycles which vary flame speeds across the combustion chamber. The inventive micro-emulsion when existing within the body of the fuel tends to reduce these cyclic dispersions. This in turn results in a smoother running engine with lower emissions, improved fuel economy and reduced engine octane requirements by maintaining cleaner combustion chambers. --

6. Paragraph beginning at page 5, line 10, has been amended as follows:

-- Thus, ~~by achieving~~ even an extremely small but beneficial effect at the on-set of combustion has a disproportionally large effect upon the manner in which the combustion subsequently progresses. This mechanism has not been appreciated and utilized by others in the past. --

7. Paragraph beginning at page 6, line 21, has been amended as follows:

-- The prior art teaches adding 10,000 ppm of emulsified water together with 5,000 ppm of surfactant which renders the background level of 100 ppm of dissolved water of no ~~significant~~ significance. However, for the present invention, this background level has significance and is not overwhelmed by addition of for example 30 ppm of emulsified water together with 75 ppm of surfactant. Knowledge of the solubility constant for the class of fuel to be treated is an important essential so that the level of background water is considered and factored into the addition. The ratio of surfactant to water is increased as necessary so that subsequent to mixing with the fuel, the ratio of surfactant to water are of within preferred ratios. --

8. Paragraph beginning at page 7, line 19, has been completely rewritten as follows:

-- Because only a small quantity of fuel additive composition is used in the hydrocarbon fuel (20 to 500ppm), it can be used like a conventional fuel additive in already existing and commercially available liquid hydrocarbon fuels. This results in several significant advantages. Even with the high ratio of surfactant to water employed in the additive, the low dose level results in a corresponding low treatment cost. Relative to the fuel savings, this gives a very cost effective product. Also, with less surfactant being used per gallon of fuel (relative to other treatments) there are less emissions from incomplete combustion of surfactants. Even if over time the micro-emulsion breaks down, the amount of released water is not large and can easily be absorbed by the fuel. The expected benefits may be lost but no damage to the engine will occur which could lead to possible product liability claims. The smaller volumes involved with these additives are more readily acceptable to oil refineries and fuel distribution centers because the hardware already exists to incorporate other types of additives on this scale into the base fuels. If the whole fuel had to be emulsified and mixed after the refining process; the complexity and effort would dictate against employment. --

~~-- Because only a small quantity of 30 ppm water is being added, a micro-emulsion forming concentrate can be used as an additive for use in already existing and commercially available liquid hydrocarbon fuels. This results in the following advantages. Even with a high ratio of surfactant to water is employed, the low water requirement overall results in a low cost treatment relative to the fuel savings. With less surfactant being used per gallon of fuel relative to other treatments, there less emissions from incomplete combustion of surfactants. Even if over time the micro-emulsion breaks down, the amount of released water is not large and can be absorbed by the fuel. The~~

~~expected improvement may be lost but no damage to the engine will occur which could lead to possible product liability claims. The smaller volumes involved with these additives are more readily acceptable to oil refineries and fuel distribution centers because the hardware already exists to incorporate other types of additives on this scale into the base fuels. If the whole fuel had to be emulsified and mixed after the refining process, the complexity and effort would dictate against employment. --~~

9. Table beginning at page 9, line 6, has been amended as follows:

<u>-- Liquid</u>	<u>Preferred Ratio</u>	<u>Ratio Range</u>
Surfactant(s)	3.0 to 1.0	8.0 to 0.5
Co-surfactant(s)	1.0 to 0.5	2.0 to 1.0 <u>0.0</u>
Water	1.0	1.0 --

10. Paragraph beginning at page 9, line 15, has been amended as follows:

~~-- Pre-diluting the concentrated additive with kerosene (or some other solvent/distillate) (to reduce its viscosity) with a hydrocarbon solvent (typically kerosene) at the ratio of from 50:1 up to 1:50 can be used to improve the additive/fuel mixing. Without adequate mixing, performance improvements may take as long as 24 hours for the concentrate to properly form into an effective emulsion after simply pouring the additive into a liquid hydrocarbon fuel. --~~

11. Paragraph beginning at page 9, line 22, has been replaced with the following paragraph:

-- Treatment levels of concentrated micro-emulsion forming additive in the liquid hydrocarbon fuel should fall within the range from about 20 to 500ppm. With more than about 500ppm of additive, the process costs too much relative to the fuel savings. With less than about 20ppm of additive, there is generally too little surfactant present for the fuel emulsion to have any long term stability. This is because the background level of dissolved water (typically 75ppm) already present in most commercially available fuels will eventually produce an unstable fuel emulsion (insufficient surfactant to water ratio).

~~-- The ratio of liquid hydrocarbon fuel to concentrated micro-emulsion forming additive should fall within the range from 240:1 to 12,000:1. The treat rates are chosen so as to result in a micro-emulsified water content added to the hydrocarbon fuel in the range from 5-95 ppm, and typically 20-80 ppm. --~~

12. Table beginning at page 31, line 12, has been amended as follows:

-- TABLE 6 (Performance Analysis Tests #1 through #20)

<u>Test #</u>	<u>Emissions Reduction</u>						
	<u>(%)</u> <u>Cost</u>	<u>(ppm)</u> <u>Water</u>	<u>(%)</u> <u>MPG</u>	<u>(%)</u> <u>HC</u>	<u>(%)</u> <u>CO</u>	<u>(%)</u> <u>NOX</u>	<u>(%)</u> <u>PM</u>

1	55	50	10	20	-	-	-
2	17	50	6	-	-	5	15
3	51	50	10	60	-	-	-
4	95	50	-	-	-	3	6
5	99	50	4	6	-	-	-
6	25	50	10	50	-	-	-
7	89	50	2	90	-	-	-
8	52	50	5	45	-	-	-
9	88	50	2	-	-	6	23
10	42	50	10	40	-	-	-
11	56	50	6	-	-	5	18
12	100	50	10	50	-	-	-
13	11	32	-	13	10	36	-
14	7	20	10	80	-	-	-
15	2	5	22 2.5	50	-	-	-
16	23	42	12	52	85	1	-
17	18	85	-	98	+35	95	-
18	9	22	14	49	-	9	22
19	11	0	-	-	-	5	15
20	7	95	10	90	-	-	-

In the CLAIMS:

Because all of the claims of record (1 – 19) have been cancelled and replaced with all new claims (20 – 35), these claims have not been included in the version with markings to show the changes.